CHEMICAL COMPOSITION, *IN VITRO* DIGESTIBILITY AND GAS PRODUCTION OF COMPOUNDED DIETS USING RUMEN LIQUOR FROM WEST AFRICAN DWARF SHEEP AND WEST AFRICAN DWARF SHEEP GOAT

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ABSTRACT
The experiment was conducted to assess the chemical composition, *in vitro* digestibility and gas production characteristics of compounded concentrate and *Panicum maximum* incubating rumen liquor collected from West African Dwarf (WAD) Sheep and Goat. The chemical composition of the diets was carried out following standard laboratory procedures, and the rumen liquor were collected from five (5) WAD sheep and goat respectively which was used in the laboratory for *in vitro* gas production procedure. Result obtained showed that the proximate composition was significantly ($p<0.05$) influenced by different feedstuffs in the gross composition, the dry matter ranged from 87.03g/100g for diet 4 - 87.82g/100g for diet 1, the highest ($p<0.05$) crude protein value (10.80%) was reported for diet 5 than other diets. Also, Values of IVGP volume for Diet 5 (23.10ml/200mgDM) was significantly higher ($p<0.05$) than diet 1(22.70ml/200mgDM); diet 2(16.70ml/200mgDM); diet 3(18.30ml/200mgDM); diet 4 (15.70ml/200mgDM); and diet 6 (21.50ml/200mgDM) using rumen liquor collected from WAD goat when compared to WAD sheep. The study concluded that the *in vitro* digestibility and gas production of compounded diets incubated with rumen liquor obtained from West African dwarf sheep and goat showed different characteristics, rumen liquor from WAD goat showed high degradability potential with high methane production.

Keyword: *Chemical composition, Rumen liquor, in vitro digestibility, WAD Sheep and Goat.*

INTRODUCTION
In vitro methods for laboratory estimations of degrading feeds are important for ruminant nutritionists, it is an efficient laboratory method that is reproducible and correlate well with measurements in *in vivo* preocedures. *In vitro* methods have the advantage not only of being less expensive and less time-consuming, and they allow Nutritionist to maintain experimental conditions more precisely than do *in vivo* trials. Rumen liquor collected from pre-fed domesticated ruminant mostly goat is employed for the incubation (Babayemi and Bamikole, 2009). Ruminants are mostly fed with natural forages, *Panicum maximum* (Guinea grass) according to FAO (2015) has been described as one of the highest yielding and most abundant grasses in the tropics used in ruminant feeding This grass are supplemented with compounded concentrates during dry season season when forages become lignified with attendant low digestibility in the tropics. The compounded concentrate utilizes use of different feedstuffs in its gross composition to meet a specific requirement depending on the animal's physiological status. The objective of this study, therefore, is to assess the chemical composition, *in vitro* digestibility and gas production characteristics of different isonitrogenous compounded concentrate with *Panicum maximum* as the basal diet employing rumen liquor from WAD Sheep and Goat.

MATERIAL AND METHOD
The experiment was conducted at the Reproductive Physiology Laboratory, Department of Animal Sciences and Sheep and Goat Unit of Teaching and Research Farm, Obafemi Awolowo University, Ile- Ife, Nigeria.

Six (6) isonitrogenous concentrate diets were compounded from different combinations for conventional feedstuffs. Presented in table 1 is the gross composition of these diets. these diets were combined with *Panicum maximum* as the basal diets. The *in vitro* gas production volume was determined according to Menke and Steingass (1988). Rumen liquor was collected from five (5) West African dwarf goats and sheep respectively in the morning before feeding, the goats and sheep were previously fed 50 % concentrate (*40 % corn bran, 13 % wheat offal, 15 % palm kernel cake, 20 % rice bran,10% maize, 0.5 % salt, 0.5 % oyster shell and 1.0 vitamin premix*) and 50 % forage. Collected rumen liquor was kept in a pre-warm flask and was sieved using cheesecloth, the rumen liquor was mixed with a McDougald buffer solution containing (9.8g/l $NaHCO_3$ + 2.77g/l Na_2HPO_4 + 0.57g/l KCl + 0.47g/l NaCl + 0.12g/l $MgSO_4.7H_2O$ + 0.16g/l $CaCl_2.2H_2O$ + 1g urea). 200mg of each diet comprising 60% *Panicum maximum* and 40% concentrate diets (120mg *Panicum maximum:* 80mg concentrate diets) was placed in a 100ml calibrated syringe in triplicates and 30ml inoculum containing cheese strained rumen liquor and buffer solution in a ratio of 1:2 was added to the 200mg of feed in the plastic syringes. Metabolizable energy (ME/MJ/kgDM) and organic matter digestibility (OMD%) were estimated as established by Menke and Steingass (1988), while short-chain fatty acids (SCFA) were calculated as described by Getachew *et al.* (1998). The gas production was measured on the calibration of the syringe at 3, 6, 9, 12, 15, 18, 21 and 24 hour. To estimate methane production by the substrate and immediately after evacuation from the incubator, 4 ml of NaOH (10 M) was introduced using a 5 ml capacity syringe. The content was inserted into the silicon tube, which was fastened to the 100 ml capacity syringe. The clip was then opened while the NaOH was gradually released. The content was agitated while the plunger began to shift position to occupy the vacuum created by the absorption of CO_2. The volume of methane was read on the calibration. To determine the actual gas produced, the average volume of gas produced from the blanks was deducted from the volume of gas produced per sample. Metabolizable energy (ME, MJ/kgDM) and organic matter digestibility (OMD, %) were estimated as established by Menke and Steingass, 1988) and short-chain fatty acids (SCFA) were computed as reported by Getachew *et al.* (1998). ME = 2.20 + 0.136GV + 0.057CP + 0.002CF, OMD = 14.89 + 0.889GV + 0.45CP + 0.651XA SCFA = 0.0239GV – 0.0601, Where GV, CP, CF and XA = gas production volume (ml/200mgDM), crude protein (%), crude fibre (%) and ash (%) of the incubated diets.

Chemical composition

Samples of each diet were taken, and oven dried at 65 ^{0}C until a constant weight was obtained for dry matter determination after which they were milled. Ether extract, crude fibre, crude protein, ash, and nitrogen Free extract of the diets were determined according to the standard procedures of AOAC (2000) and crude fibre fractions were determined according to the procedure of Van-Soest *et al.*, (1994)

Experimental Design and Statistical Analysis

The experiment was laid out in a Randomized Complete Block Design. Data obtained were subjected to Analysis of Variance using the General Linear Model procedures of SAS (2001). Significant differences between means were compared using the Duncan New Multiple Range tests of the same package

RESULT AND DISCUSSION

Table 2 presents the chemical composition of the experimental diets. The dry matter ranged from 87.03g/100g for diet 4 to 87.82g/100g for diet 1. The highest crude protein value (10.80%) was reported for diet 5, the CP contents for all diets exceeded the minimum level of 8% maintenance requirement for ruminants in the tropics (NRC, 2007). The highest crude protein value recorded for diet 5 may be attributed to the high biological value of the feedstuffs as presented in the gross composition (Table 1). The NFE values indicated that there were sufficient fermentable carbohydrates in the diets for energy production. Nitrogen free extract values were highest in diet 1 and 2 (63.11 and 63.07) respectively this may be because of the higher level of corn bran in the diets. The Neutral detergent fibre (NDF) (54.58%) for Diet 4 was significantly higher ($p<0.005$) than other diets, the bulkiness reported for diet 4 may be ascribed to the high inclusion level of rice bran in the diet.

Presented in table 3 are the *in vitro* gas production volumes, metabolizable energy, organic matter digestibility and short-chain fatty acid of the experimental diets, this table also presents differences obtainable from using rumen liquor from different species. Values of IVGP for Diet 5 (23.10ml/200mgDM) was significantly higher ($p<0.05$) than diet 1(22.70ml/200mgDM); diet 2(16.70ml/200mgDM); diet 3(18.30ml/200mgDM); diet 4 (15.70ml/200mgDM); and diet 6 (21.50ml/200mgDM) using rumen liquor collected from WAD goat, this connotes that more carbohydrate fermentation took place in diet 5 and also that diet 5 had higher nutritive potentials than the other diets for WAD goat. However, Values of IVGP for diets followed a different pattern from incubation from rumen liquor obtained from Sheep, IVGP volume were significantly ($p<0.05$) higher from product of incubation from rumen liquor from goat compared to sheep for for diet 1 (22.70ml/200mg : 17.80ml/200mg); 3 (18.30 ml/200mg : 16.60ml/200mg); 5 (23.10ml/200mg : 17.60ml/200mg) and 6 (21.50ml/200mg : 16.80ml/200mg) respectively, this might be attributed to the difference in the microbial population differences in the rumen of goat and sheep. Diet 1 and 5 were significantly higher ($p<0.05$) in ME, OMD and SCFA, implying that Diet 1 and 5 had higher energy potentials than the other diets because high ME and SCFA implies energy availability. This agrees with the report of Oloche *et al*. (2013) that, high SCFA is an indicator of energy availability. Observed ME, OMD and SCFA values were comparable with the report of Abegunde *et al*. (2010) who reported 4.45-5.99 MJ/kgDM, 38.32-50.33% and 0.25-0.51 mmol/200mgDm for ME, OMD and SCFA respectively for *Ficus exasperata* diets. Methane production which implies energy loss was significantly higher for diet 2 with 47.31% than other diets for degradation using rumen liquor obtained from goat. Also, it was observed that there is a significantly ($p<0.05$) higher methane production from goat when compared to Sheep. Presented in figures 1 & 2 are the total gas production volume for each of the diet, which revealed significant ($p<0.05$) variation among the diets. This implies high gas production from using rumen liquor from goat when compared to sheep.

Table 1: Gross Composition of Concentrate Diets for growing WAD Goat

	Diets					
Ingredients (%)	1	2	3	4	5	6
Maize	43.33	-	17.65	-	40.63	29.82
Groundnut cake	8.31	3.31	-	-	-	-
Wheat Offal	6.30	3.48	42.34	9.48	10.30	19.51
Rice bran		47.65	19.00	40.69	-	-
Palm Kernel Cake	-	-	-	10.27	-	21.13
Corn Bran	40.06	43.56	19.01	37.56	37.50	27.54
Soya bean Meal					9.84	-
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Vit Premix	1.50	1.50	1.50	1.50	1.50	1.50
Calculated analyses						
Crude protein	14.00	14.00	14.00	14.00	14.00	14.00
Crude Fibre	8.64	13.99	9.99	14.18	8.50	10.56
Ash	5.43	8.99	10.30	9.19	5.25	6. 90
Neutral detergent fibre	33.63	47.89	31.56	49.48	33.78	41.14

Table 2: Chemical Composition of the Concentrate Diets and *Panicum maximum* (40:60)

	Diets							
Parameters (%)	1	2	3	4	5	6	SEM	P value
Dry Matter	87.82^{a}	87.58^{ab}	87.50^{ab}	87.03^{c}	87.18^{bc}	87.62^{ab}	0.08	0.0148
Crude Protein	10.57^{b}	10.17^{c}	10.35^{c}	10.65^{ab}	10.80^{a}	10.17^{c}	0.06	<0.0001
Crude Fibre	16.31^{c}	17.12^{bc}	17.58^{b}	19.97^{a}	19.82^{a}	17.67^{b}	0.35	<0.0001
Ether Extract	2.49^{b}	2.29^{b}	2.30^{b}	2.41^{b}	2.48^{b}	2.91^{a}	0.05	0.0016
Ash	7.51	7.33	7.42	7.54	7.43	7.47	0.04	0.7868
NFE	63.11^{a}	63.07^{a}	62.34^{b}	59.43^{d}	59.45^{d}	61.78^{c}	0.38	<0.0001
NDF	48.14^{c}	53.76^{a}	48.23^{c}	54.58^{a}	48.58c	52.19^{b}	0.66	<0.0001
ADF	27.21^{cd}	30.88^{b}	26.09^{d}	33.00^{a}	25.69^{d}	28.62^{c}	0.66	<0.0001
ADL	5.81^{f}	7.17^{b}	6.21^{e}	7.45^{a}	6.41^{d}	6.73^{c}	0.13	<0.0001
Cellulose	21.39^{cd}	23.69^{b}	19.87^{de}	25.54^{a}	19.27^{e}	21.88^{c}	0.55	<0.0001
Hemicellulose	20.92^{d}	21.60^{cd}	22.14^{bc}	21.58^{cd}	22.89^{ab}	23.58^{a}	0.24	0.0026

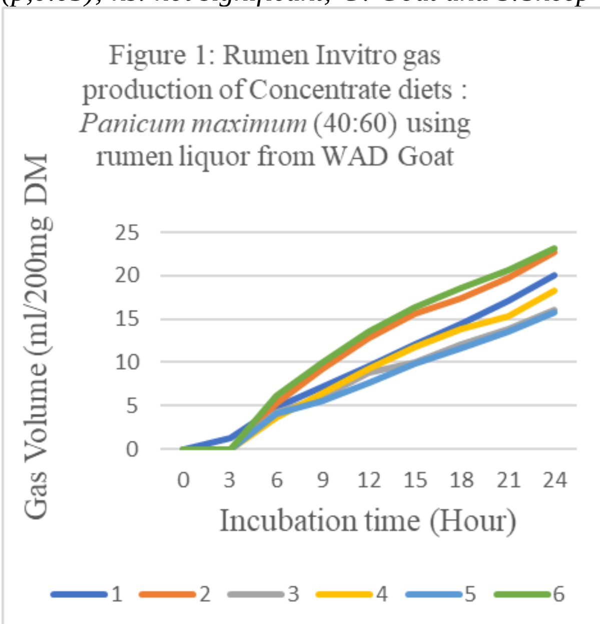
^{a,b,c} = Means on the same row with different superscripts are significantly different ($p<0.05$); *NFE: Nitrogen free extract; NDF: Neutral detergent fibre; ADF: Acid detergent fibre; ADL: Acid detergent lignin*

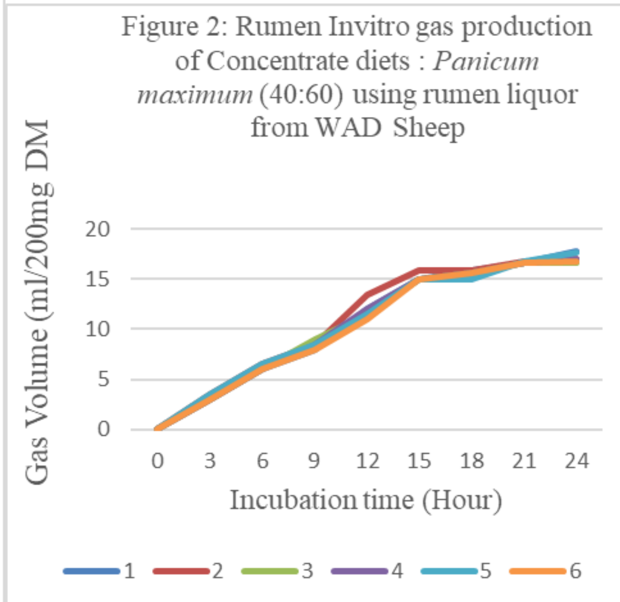
Table 3: *In vitro* gas production, metabolisable energy, organic matter digestibility and short-chain fatty acid of diets

		Diets							
Parameter(s)	Specie	1	2	3	4	5	6	SEM	P value
IVGP (ml/200mg)	G	22.70^{ax}	16.70^{d}	18.30^{cx}	15.70^{a}	23.10^{ax}	21.50^{bx}	0.74	<0.0001
	S	17.80^{ay}	17.00^{b}	16.60^{cy}	16.60^{c}	17.60^{ay}	16.80^{bcy}	0.11	<0.0001
	SEM	1.09*	0.10ns	0.39*	0.27ns	1.24*	1.07*		
CH_4 (ml/200mg)	G	9.30^{abx}	7.90^{cx}	7.90^{cx}	7.30^{dx}	9.10^{bx}	9.50^{ax}	0.21	<0.0001
	S	6.19^{aby}	6.30^{ay}	5.85^{by}	6.25^{ay}	5.99^{by}	6.00^{by}	0.14	0.0231
	SEM	0.69*	0.37ns	0.37*	0.29*	0.25*	0.81*		
ME(MJ/kgDM)	G	5.92^{a}	5.00	5.30^{c}	4.98^{a}	5.99^{ax}	5.74^{b}	0.13	<0.0001
	S	5.26^{ay}	5.13^{ab}	5.08^{b}	5.08^{ay}	5.25^{ay}	5.10^{aby}	0.02	<0.0001
	SEM	0.15*	0.08ns	0.09ns	0.17ns	0.25*	0.26*		
OMD (%)	G	44.72^{ax}	38.55^{cx}	40.65^{cx}	38.55^{cx}	45.12^{ax}	43.44^{bx}	0.08	<0.0001
	S	40.36^{ay}	39.35^{by}	39.14^{by}	38.55^{b}	40.23^{ay}	39.26^{by}	0.23	<0.0001
	SEM	0.97*	0.24*	0.48*	0.17ns	1.11*	0.96*		
SCFA (μmol/200mgDM)	G	0.48^{ax}	0.32^{d}	0.38^{c}	0.32^{dx}	0.49^{ax}	0.45^{bx}	0.08	0.0002

S	0.37[y]	0.35	0.35	0.35[y]	0.36[y]	0.34[y]	0.08	0.7002
SEM	0.03*	0.07ns	0.07ns	0.03ns	0.04ns	0.03*		

[a,b,c] = Means on the same row with different superscripts are significantly different ($p<0.05$); [x,y] = Means on the same column within a parameter with different superscripts are significantly different ($p<0.05$) *SEM = Standard error of the mean; IVGP = In vitro gas production at 24hr; ME = Metabolizable energy, OMD = Organic matter digestibility, SCFA = Short chain fatty acid;* CH_4 *=Methane; * : significantly different (p,0.05); ns: not significant; G: Goat and S:Sheep*





Conclusion

It can be concluded that the *in vitro* digestibility and gas production of compounded diets incubated with rumen liquor collected from West African dwarf sheep and goat showed different characteristics, rumen liquor from WAD goat showed higher degradability ability with high methane production, this implies high energy loss by WAD goat while better utilization was displayed by WAD Sheep.

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